Iodine-Compatible Photocathode for RF Ion Thrusters, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

Iodine is highly attractive as an alternate electric propulsion propellant to xenon. It is easily stored in a compact volume on a spacecraft as a solid (greater than twice the storage density than pressurized xenon), which negates the need for a large pressurized tank. This, combined with its low cost and lower ionization energy, make iodine an ideal propellant for a smallsat electric thruster system. Busek currently is developing a line of gridded Radio-Frequency (RF) ion thrusters that utilize iodine as a propellant. In addition to their small size, the thrusters are low power and are compatible with solid-storable propellant iodine. This makes the BIT thruster line a mission-enabling technology for situations where volume and mass are highly constrained. The current generation of BIT thrusters use the BRFC-1, an RF-ion cathode to provide the neutralization current. The BRFC-1 consists of a miniaturized BIT-1 thruster, modified to extract electrons instead of ions. This cathode realization has three main limitations: Power processing complexity, feed system complexity, and reduced system Isp (due to the need to flow propellant to the cathode that does not generate thrust). We propose to develop a photocathode that will produce a current to both ignite and neutralize the Busek line of RF ion thrusters that is highly efficient and iodine compatible. A photocathode emits electrons when struck by an incident light beam. This cathode, when combined with an efficient UV light source, is predicted to significantly decrease the power requirements of the BIT thruster line while drastically improving Isp due to its propellantless operation. The proposed work will measure the quantum efficiency of specially-fabricated photocathodes before and after iodine exposure to evaluate their potential as an RF thruster neutralizer technology.

Anticipated Benefits

A void exists for miniature thruster systems capable of delivering km/s delta-V for MicroSats. Many novel and new missions are achievable with high delta-V, low thrust propulsion systems. Example NASA missions include highly non-Keplerian orbits for communications, observation, and planetary transfers, such as lunar and deep space missions utilizing weak stability boundary transfers, Saturn Ring observer missions, and missions requiring spacecraft to 'hover' next to near-earth objects.

Civil and DoD applications of highly non-Keplerian orbits enabled by electric propulsion include 'polesitter' type orbits for observation/communication with the Earth's polar regions. The Busek iodine RF ion engine system enables small, relatively low cost LEO, MEO, and GEO constellations and the technology provides a low risk method of demonstrating many novel orbital maneuvers.

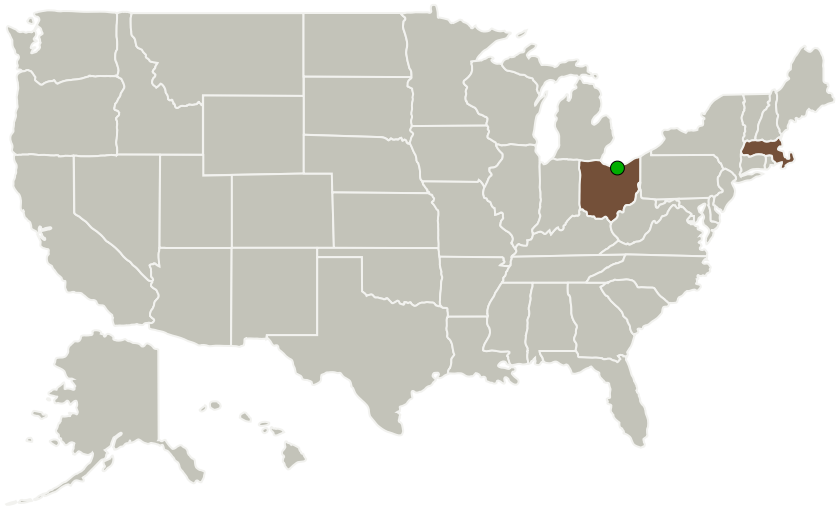
Iodine-Compatible Photocathode for RF Ion Thrusters, Phase I

Table of Contents

Iodine-Compatible Photocathode for RF Ion Thrusters, Phase I

Completed Technology Project (2018 - 2019)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Busek Company, Inc.	Lead Organization	Industry Women-Owned Small Business (WOSB)	Natick, Massachusetts
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Massachusetts	Ohio

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Busek Company, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

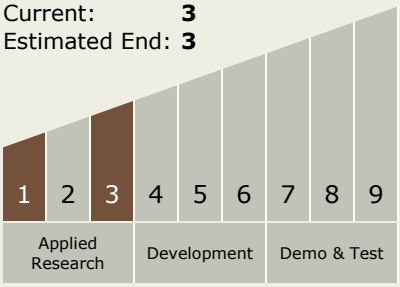
Carlos Torrez

Principal Investigator:

Yu-hui Chiu

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



Iodine-Compatible Photocathode for RF Ion Thrusters, Phase I

Completed Technology Project (2018 - 2019)

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137847)*

Images

Briefing Chart Image
Iodine-Compatible Photocathode for RF Ion Thrusters, Phase I
(https://techport.nasa.gov/image/132153)

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.2 Electric Space Propulsion
    - TX01.2.2 Electrostatic

Target Destinations

Earth, The Moon, Mars